Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 30 minutes

Paper reference **WPH11/01**

Physics

International Advanced Subsidiary/Advanced Level
UNIT 1: Mechanics and Materials

You must have:
Scientific calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In the question labelled with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

Pearson

SECTION A

Answer ALL questions.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Which of the following is a scalar quantity?

☒ **A** displacement

☒ **B** moment of a force

☒ **C** power

☒ **D** weight

(Total for Question 1 = 1 mark)

2 Which of the following describes gravitational field strength?

☒ **A** weight per unit mass

☒ **B** acceleration per unit mass

☒ **C** gravitational potential energy per unit mass

☒ **D** acceleration per unit weight

(Total for Question 2 = 1 mark)

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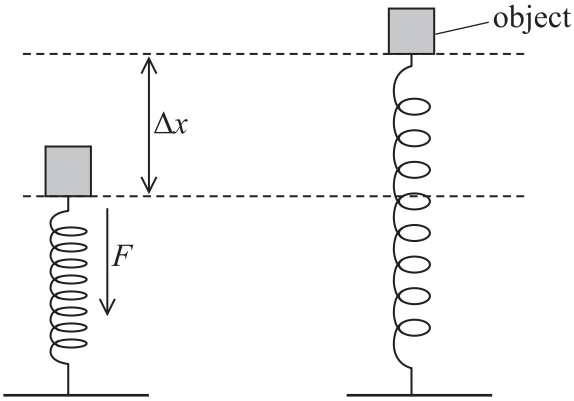
3 An object of mass m is resting on top of a spring. The spring is compressed a further distance Δx by a vertical force F. The force is removed and the spring returns to its original length as shown.



When Δx becomes zero the object has a vertical speed v.

Which of the following equations describes the energy transfer as the spring returns to its original length?

☒ **A** $\frac{1}{2} F \Delta x = \frac{1}{2} m v^2 - m g \Delta x$

☒ **B** $\frac{1}{2} F \Delta x = \frac{1}{2} m v^2 + m g \Delta x$

☒ **C** $F \Delta x = \frac{1}{2} m v^2 - m g \Delta x$

☒ **D** $F \Delta x = \frac{1}{2} m v^2 + m g \Delta x$

(Total for Question 3 = 1 mark)

4 A student measures the time taken for a steel ball bearing to fall a measured distance in air. The student uses these measurements to determine the acceleration due to gravity.

Which of the following conditions is needed to determine an accurate value for the acceleration due to gravity?

☒ **A** The air flow around the ball bearing should be laminar.

☒ **B** The time taken to achieve terminal velocity should be short.

☒ **C** The ball bearing should begin to fall before the timer is started.

☒ **D** Air resistance and upthrust should both be negligible.

(Total for Question 4 = 1 mark)

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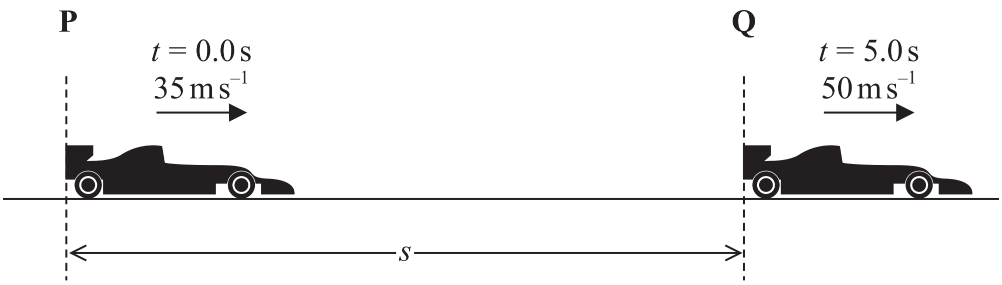
5 A racing car passes point P at a speed of $35\,\text{m}\,\text{s}^{-1}$.

The car accelerates uniformly and after 5.0 s passes point Q at a speed of $50\,\text{m}\,\text{s}^{-1}$, as shown.



Which of the following expressions gives the distance s, in metres, between the two points?

☒ **A** $\dfrac{50^2 - 35^2}{2 \times 5}$

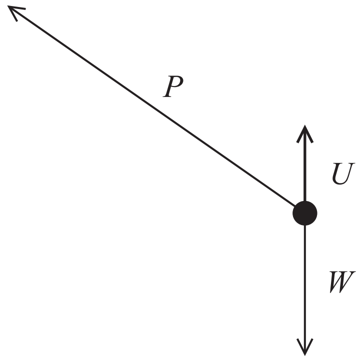
☒ **B** $(35 \times 5) + (0.5 \times 9.81 \times 5^2)$

☒ **C** $0.5 \times (35 + 50) \times 5$

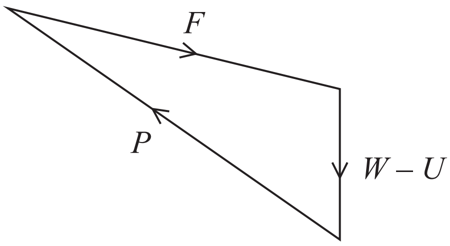
☒ **D** $35 + (9.81 \times 5)$

(Total for Question 5 = 1 mark)

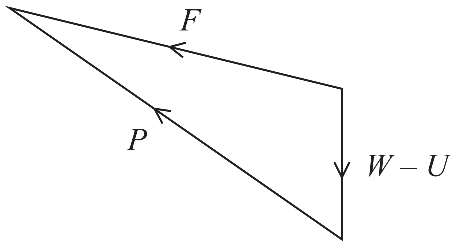
6 A soap bubble is being blown by the wind. The free-body force diagram shows the forces acting on the bubble. *P* is the force of the wind, *W* is the weight of the bubble and *U* is the upthrust acting on the bubble.



Which of the following vector diagrams shows the resultant force *F* acting on the bubble?



A



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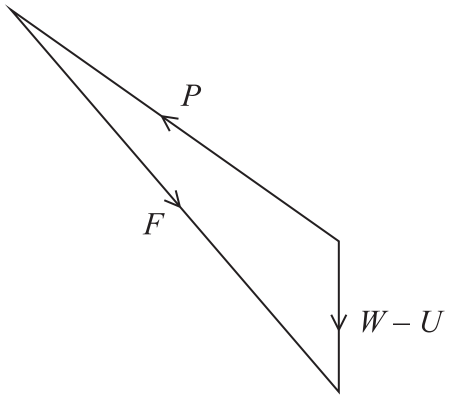
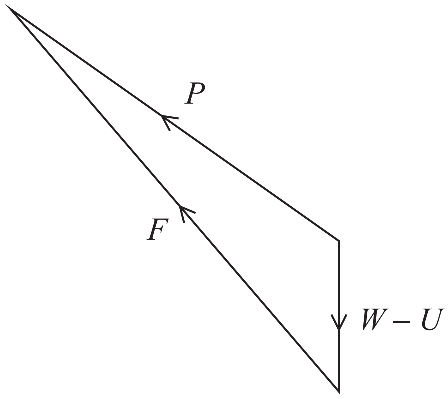


C



D

☒ **A**

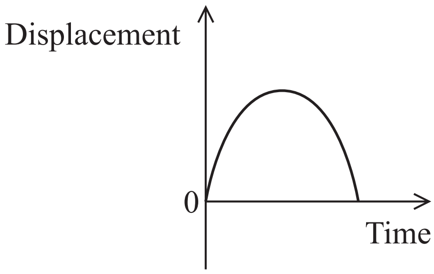
☒ **B**

☒ **C**

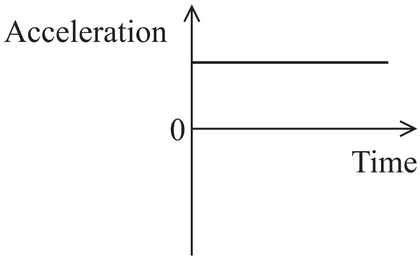
☒ **D**

(Total for Question 6 = 1 mark)

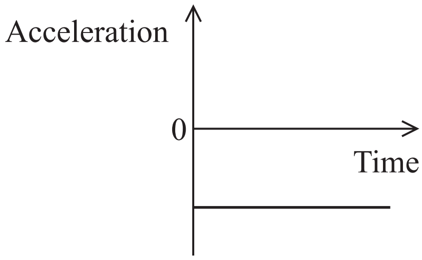
7 A person threw a ball vertically up in the air and caught the ball a few seconds later. The graph of vertical displacement against time for the ball is shown.



Which graph shows the acceleration of the ball against time?



A



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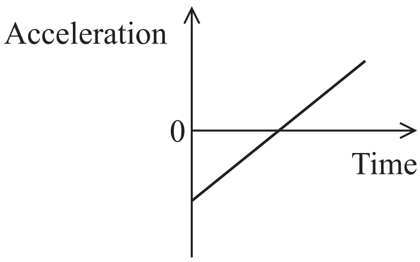

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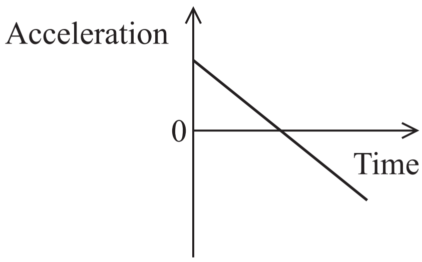

D

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 7 = 1 mark)

P 7 1 8 6 4 A 0 6 2 8

8 A motor lifts a mass of 50 000 kg through a vertical height of 25 m.

The motor has an output power of 700 kW.

Which of the following gives the time in seconds taken to lift the mass?

☒ **A** $\frac{50\,000 \times 25}{700\,000}$

☒ **B** $\frac{50\,000 \times 9.81 \times 25}{700\,000}$

☒ **C** $\frac{50\,000 \times 25}{700}$

☒ **D** $\frac{50\,000 \times 9.81 \times 25}{700}$

(Total for Question 8 = 1 mark)

9 A student carries out an experiment to determine the Young modulus of copper.

The student adds known masses to a copper wire and measures the corresponding extensions of the wire.

Which other quantities should the student measure directly?

☒ **A** diameter and mass of the wire

☒ **B** diameter and original length of the wire

☒ **C** radius and mass of the wire

☒ **D** radius and original length of the wire

(Total for Question 9 = 1 mark)

10 Two forces make a Newton’s third law pair.

Which of the following statements is true for these forces?

☒ **A** They act in different directions on the same body.

☒ **B** They are the same type of force and act on different bodies.

☒ **C** They have different magnitudes and act in different directions.

☒ **D** They are the same type of force and have different magnitudes.

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

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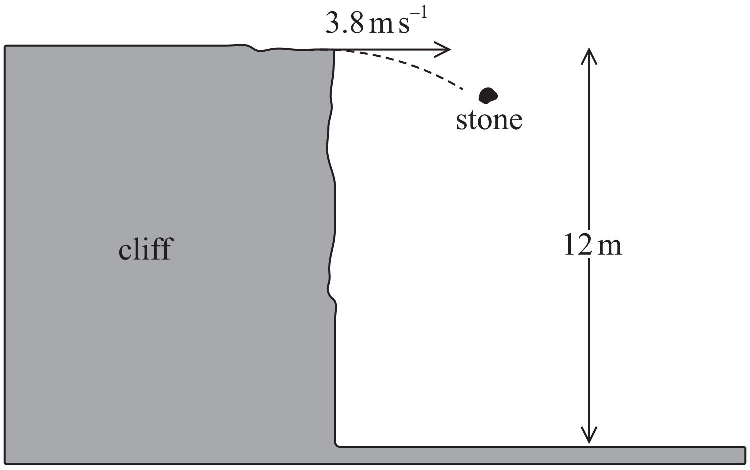
SECTION B

Answer ALL questions in the spaces provided.

11 A stone is projected horizontally from a cliff.

The initial horizontal velocity of the stone is $3.8\,\mathrm{m\,s^{-1}}$.

The initial height of the stone is 12 m, as shown.



Calculate the horizontal distance from the bottom of the cliff to where the stone hits the ground.

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Horizontal distance = ...

(Total for Question 11 = 3 marks)

12 A student determined the viscosity of a liquid using the falling-ball method.

(a) When the ball is falling at terminal velocity the following equation applies

drag force = weight of ball – upthrust

The density of the liquid was known.

The student used a balance and a digital calliper to make measurements on the ball.

Describe how the student could use her measurements to calculate a value for the drag force acting on the ball.

(4)

(b) When falling through the liquid, the ball reached terminal velocity.

The flow of liquid around the ball was laminar.

Calculate the viscosity of the liquid.

terminal velocity of ball = $5.4 \times 10^{-4}\,\mathrm{m\,s^{-1}}$
radius of ball = $0.50 \times 10^{-2}\,\mathrm{m}$
drag force = $1.1 \times 10^{-2}\,\mathrm{N}$

(2)

Viscosity of liquid = ...

(Total for Question 12 = 6 marks)

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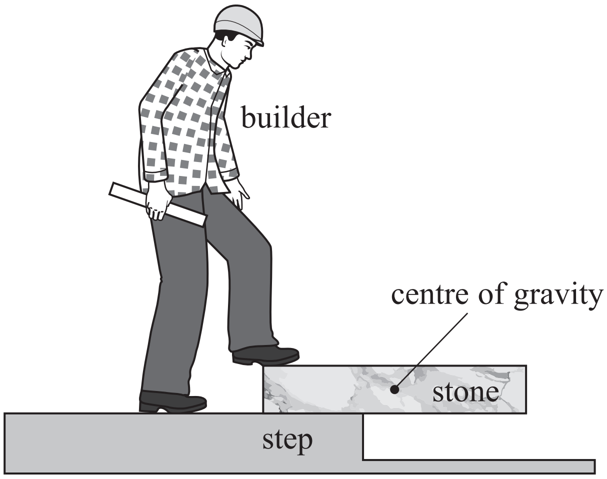
13 A builder is making a path using uniform rectangular stones. A stone is resting horizontally on a step and is held in equilibrium by the builder's foot.

The centre of gravity of the stone is at its centre, as shown.



(a) (i) State what is meant by equilibrium.

(2)

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(ii) State what is meant by the centre of gravity of an object.

(1)

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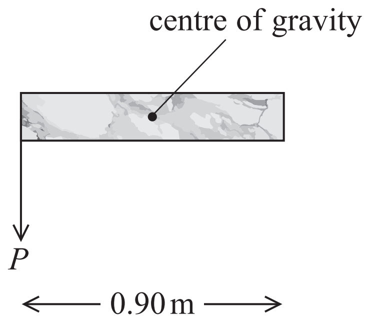
(b) The builder applies the minimum force P that will keep the stone in equilibrium.

(i) The position and direction of P are shown on the diagram below.

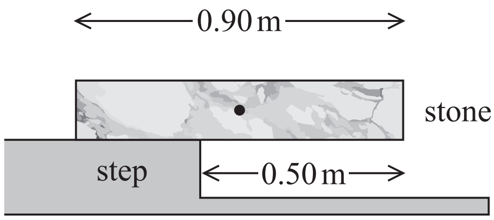


Complete the diagram above by adding labelled arrows to show the positions and directions of the other forces acting on the stone.

(2)

(ii) The stone has a weight of 415 N and a length of 0.90 m.

The length of the stone beyond the edge of the step is 0.50 m, as shown below.



The centre of gravity is at the centre of the stone.

Calculate the magnitude of P.

(3)

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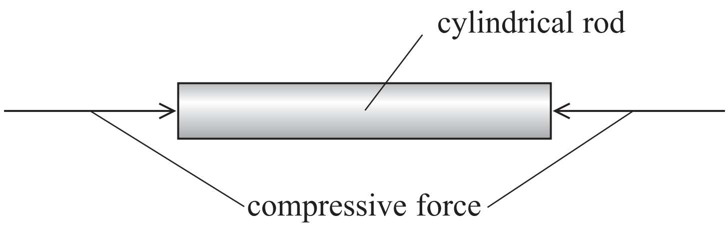
Magnitude of P = ...

(Total for Question 13 = 8 marks)

14 An engineer is designing a metal part for a machine. The part is in the form of a cylindrical rod. The part is designed to behave elastically when compressive forces are applied, as shown.



(a) State what is meant by elastic deformation.

(1)

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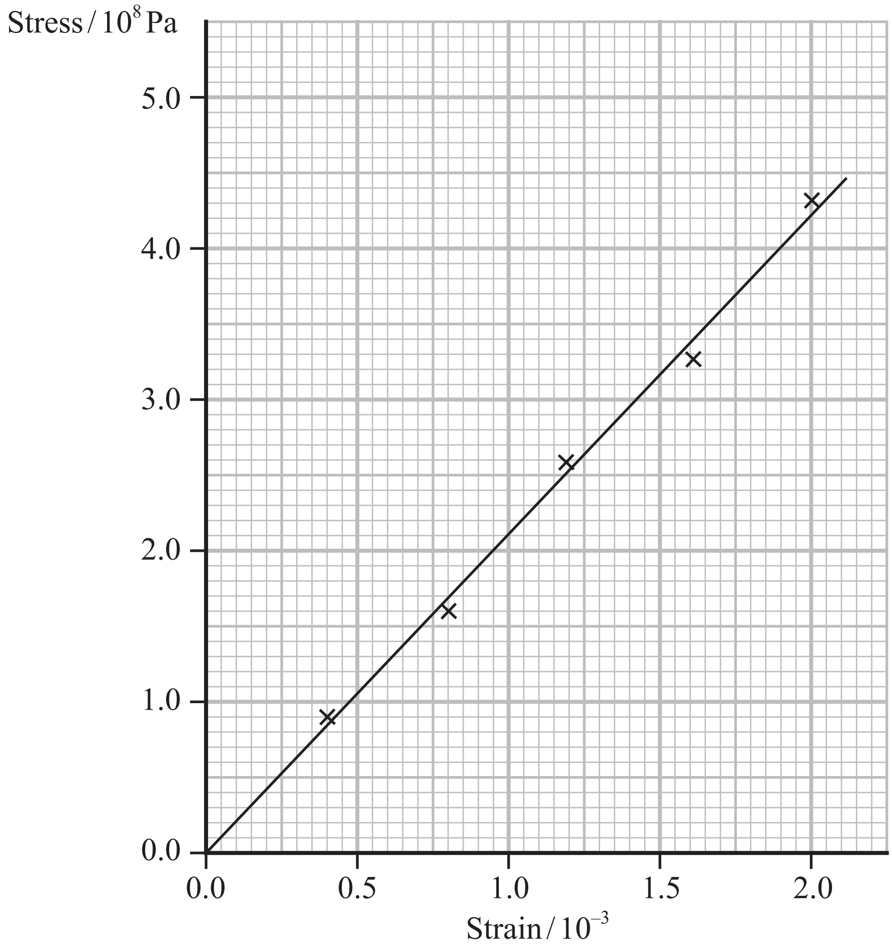
(b) A compressive stress-strain graph for one metal is shown.



P 7 1 8 6 4 A 0 1 4 2 8

(i) Show that the Young modulus for this metal is about 2×10^{11} Pa.

(2)

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(ii) The metal part must not compress more than 0.60 mm when a force of 9.5×10^{5} N is applied.

Deduce whether this metal is suitable for the part.

length of part = 0.84 m
cross-sectional area of part = 4.8×10^{-3} m^{2}

(4)

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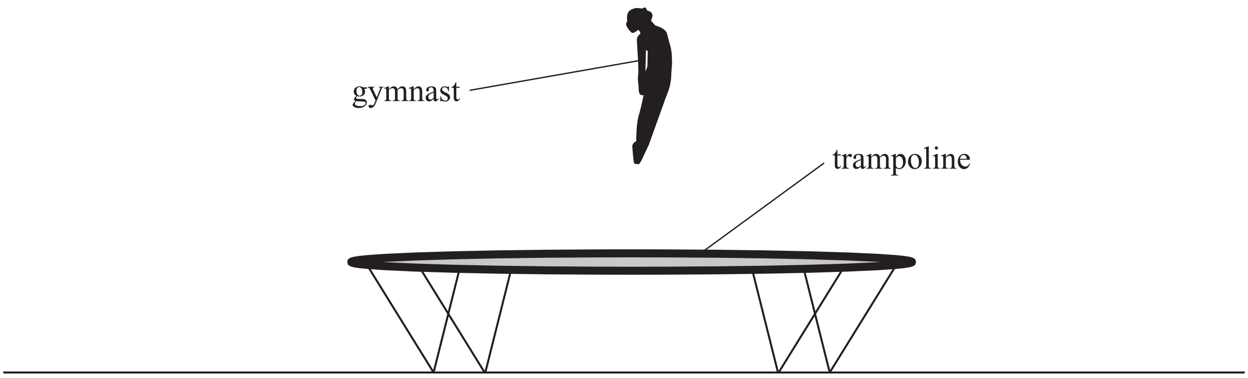
(Total for Question 14 = 7 marks)

15 A gymnast bounces on a trampoline.

For part of each bounce, the gymnast is in contact with the trampoline. For the rest of each bounce the gymnast is in the air, as shown.



(a) The trampoline gives the gymnast a maximum upward acceleration of $14.2\,m\,s^{-2}$.

Calculate the maximum upward force of the trampoline on the gymnast.

mass of gymnast = 58 kg

(4)

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Maximum upward force = ...

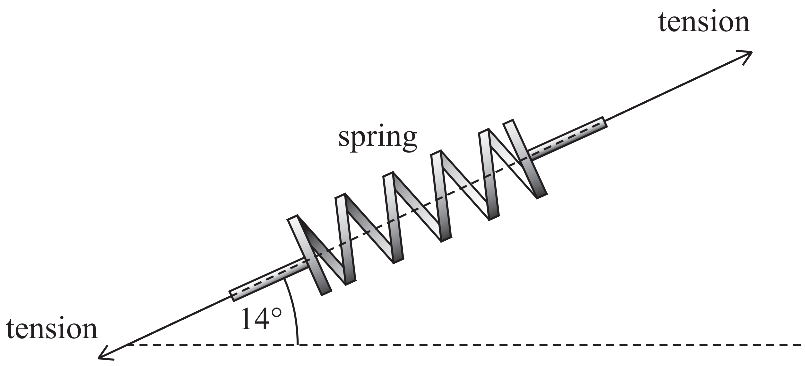
P 7 1 8 6 4 A 0 1 6 2 8

(b) The trampoline is made of a sheet of material attached to a frame by springs.

The vertical components of the tension in the springs provide the upward force on the gymnast.

The vertical component of the tension in one spring is 68 N when the spring makes an angle to the horizontal of 14°, as shown below.

Not to scale



(i) Show that the tension in the spring is about 300 N.

(2)

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(ii) The extension of the spring was 4.6×10^{-2} m.

Calculate the stiffness of the spring.

(2)

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Stiffness = ...

*(c) The vertical acceleration of the gymnast varies while she is in contact with the trampoline.

Explain how the forces on the gymnast affect the vertical acceleration while she is in contact with the trampoline.

Your answer should identify the forces acting on the gymnast and the directions of the forces. Ignore air resistance.

(6)

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(Total for Question 15 = 14 marks)

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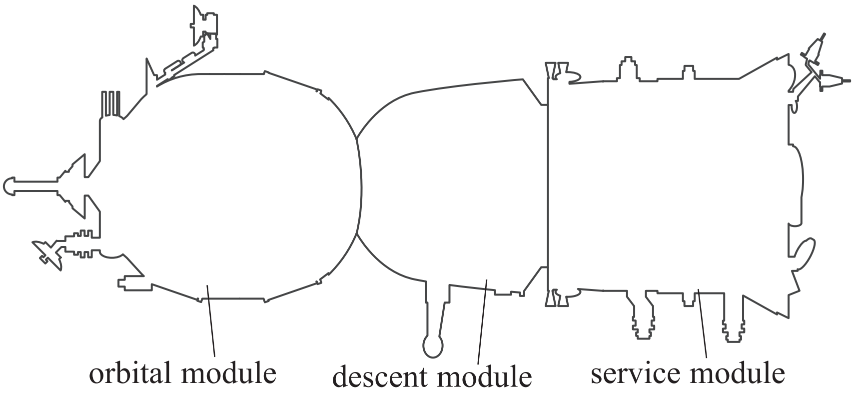
P 7 1 8 6 4 A 0 1 9 2 8

16 A spaceship is used to take astronauts and equipment to the International Space Station. The spaceship consists of an orbital module, a descent module and a service module, as shown.

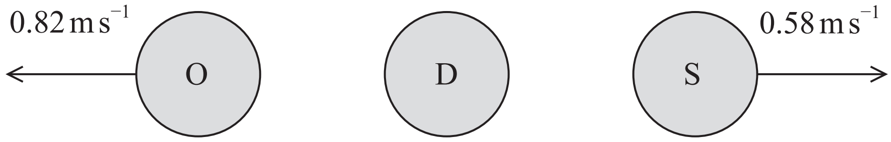


(Source: © NASA)

The astronauts return to Earth in the descent module.

Before entering the Earth's atmosphere, the modules separate.

The orbital module (O) and service module (S) move away from the descent module (D) in opposite directions, as shown below.



(a) Determine the velocity v of the descent module after separation.

You should only consider momentum along a horizontal line through the centres of the three modules.

mass of O = 1350 kg
mass of D = 2950 kg
mass of S = 2100 kg

(4)

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Magnitude of v = ... Direction of v = ...

(b) The velocity of the descent module can be changed using a rocket motor. The rocket motor ejects hot gases at high velocity.

(i) Explain why the velocity of the descent module changes when the rocket motor is used.

Your answer should refer to Newton's laws of motion.

(3)

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(ii) When the rocket motor is operating, the velocity of the descent module changes by $0.58\,\mathrm{m\,s^{-1}}$ during a time of 5.0 seconds.

mass of descent module = 2950 kg

Calculate the average force exerted on the hot gas during this time.

(3)

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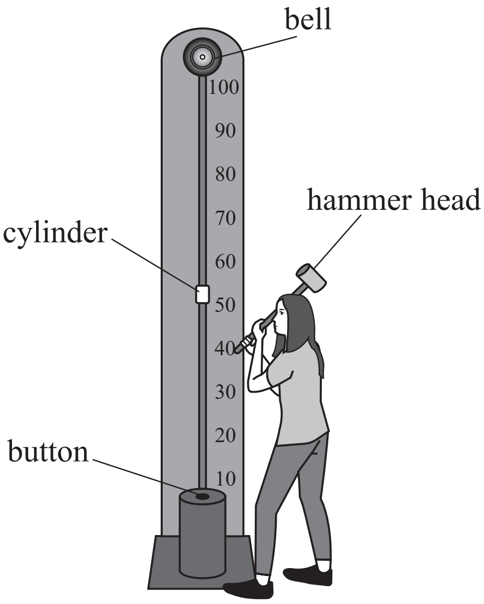
Average force = ...

(Total for Question 16 = 10 marks)

17 In a game called 'High Striker' a person hits a button with a hammer. This causes a cylinder to move towards the bell at the top, as shown.



(a) The kinetic energy of the hammer head as it hits the button is greater than the change in gravitational potential energy of the hammer head as it moves down.

Explain why.

(3)

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(b) The hammer is initially at rest at its highest point. As the person moves the hammer head towards the button, the average resultant force on the hammer head is 58 N.

The hammer head moves a distance of 1.2 m before hitting the button. The cylinder must move 2.7 m upwards to hit the bell.

Deduce whether the cylinder hits the bell.

mass of cylinder = 0.15 kg
efficiency of energy transfer = 4.0 %

(5)

(c) If the velocity of the hammer head as it hits the button doubles, the height gained by the cylinder does **not** double.

Explain why.

(2)

(Total for Question 17 = 10 marks)

18 An object of mass 35 kg fell from a boat to the seabed.

(a) The object reached terminal velocity as it fell.

(i) Show that the drag force acting on the object at terminal velocity was about 200 N.

volume of object = $1.60 \times 10^{-2}\,\text{m}^3$
density of seawater = $1.03 \times 10^{3}\,\text{kg m}^{-3}$

(5)

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(ii) The drag force D on the object obeyed the formula

$$D = kv^2$$

where v is the speed of the object.

Determine the terminal velocity of the object.

$k = 2.2\,\text{N s}^2\,\text{m}^{-2}$

(2)

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Terminal velocity = ...

(iii) Give **two** reasons why Stokes' law could **not** be used to calculate the terminal velocity of the object.

(2)

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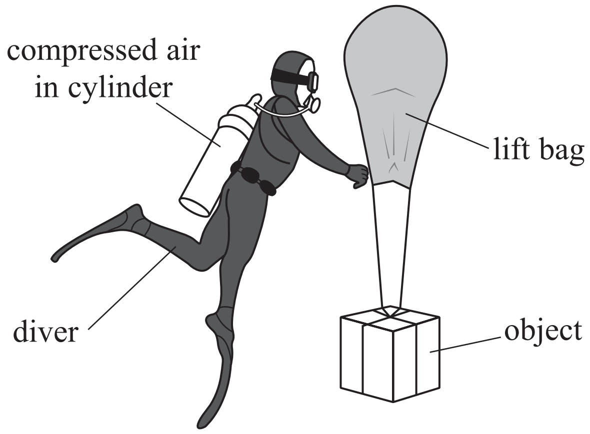
(b) To lift the heavy object from the seabed, a diver used a 'lift bag'.

The diver used compressed air from a cylinder to fill the lift bag, as shown.



When released, the lift bag and object accelerated upwards until they reached a maximum velocity.

Explain why the lift bag and object reached a maximum velocity.

(3)

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(Total for Question 18 = 12 marks)

TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)

Unit 1

Mechanics

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_\text{k} = \frac{1}{2}mv^2$$

$$\Delta E_\text{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density

$$\rho = \frac{m}{V}$$

Stokes' law

$$F = 6\pi\eta rv$$

Hooke's law

$$\Delta F = k\Delta x$$

Elastic strain energy

$$\Delta E_\text{el} = \frac{1}{2}F\Delta x$$

Young modulus

$$E = \frac{\sigma}{\varepsilon} \text{ where}$$

$$\text{Stress } \sigma = \frac{F}{A}$$

$$\text{Strain } \varepsilon = \frac{\Delta x}{x}$$

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